Artificially Dwarfed Plants

Pest Risk Assessment on Certain Wood Boring Beetles Known to Be Associated With Artificially Dwarfed Plants (ADP): Citrus Longhorned Beetle (CLB), (*Anoplophora chinensis*), The White Spotted Longhorned Beetle (WSLB), (*Anoplophora malasiaca*), and *Chlorophorus diadema*.

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Agency Contacts:

Paul A. Courneya, Agriculturalist
Joseph F. Cavey, Branch Chief

National Identification Services
Biological and Technical Services
Plant Protection and Quarantine
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
4700 River Road, Unit 133
Riverdale, MD 20737-1236

Executive Summary

We conducted a plant pest risk assessment to examine the risks posed by three wood boring insect taxa intercepted from artificially dwarfed plants (ADP) imported into the United States. Our risk assessment was conducted according to accepted international guidelines for plant pest risk analyses.

After introductory comments, citations of previous assessments and studies, and a discussion of interceptions of the pests, we document the quarantine status of the taxa covered by the assessment. Then for each taxon, we provide a detailed discussion supporting our rating for the likelihood of entry, likelihood of establishment and consequence of the establishment of these organisms.

This assessment does not make up a comprehensive account of the known biology and documented scientific literature on several taxa of woodboring beetles associated with ADP. However, we present considerable and detailed information on these taxa that shows an obvious pattern of significant risk. The likelihood of entry for two of these taxa is high. European officials have intercepted them in quarantine activities. Also, adult and immature beetles have been found at port of entry, greenhouse and domicile locations throughout the United States. We rate the likelihood of establishment for the three taxa herein as high due to their wide distribution in tropical and subtropical regions and wide host ranges that include tree species growing in the United States.

We rate the consequences of introduction (entry and establishment) for all these taxa as high. Although the amount of available information on damage caused by these three taxa varies, we present detailed information from the scientific literature on the impacts of these pests in China and other areas of the world. We found that each of these insect genera contains pests of ornamental, orchard and environmentally significant tree groups, and that some of these pests (e.g., Citrus longhorned beetle) could have devastating impact on agriculture systems or the environment.

Finally, we rate the overall pest risk potential for each of the three taxa as high. Our high rating results from the finding that the risk of introduction is from medium to high and that, if introduced the United States, these pests will have a significant adverse impact.

I. Introduction

This pest risk assessment is prepared by Plant Protection and Quarantine (PPQ) within the Animal Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA). This document will examine the plant pest risk associated with the importation of artificially dwarfed plants (ADP) into the United States of America.

Many important organisms including species of wood boring beetles can infest ADP. An important exclusion tool used by those delegated the responsibility to prevent the introduction and spread of harmful plant pests into the United States is the foreign plant quarantine. The foreign plant quarantine applicable to this document is Title 7 of the Code of Federal Regulations Part 319.37, because it incorporates provisions to prohibit or restrict the importation of certain plants and plant products.

The volume of ADP imported into the United States has increased dramatically in recent years. For example, in 1993, we imported fewer than 600 plants. In 1998, the number of ADP imported climbed to 54,749 plants. As the volume of ADP increased, the problem of adequately inspecting large volumes of ADP for harmful pests surfaced. It has become apparent to the USDA that there is a need to adjust the regulations as it applies to ADP, especially to address those plants dwarfed by natural phenomena. We believe that many of these type dwarfed plants may be field collected, produced quickly in the country of origin and export in mass. In addition, plants collected in the field may include species that, historically, they have not imported as ADP. If so, these plants may lack the same meticulous care and applied safeguards as traditional ADP such as bonsai and penjing.

Compliance with International Standards

Two international plant protection organizations, The North American Plant Protection Organization (NAPPO) and the International Plant Protection Convention (IPPC) of the United Nations Food and Agriculture Organization (FAO), provide guidance for conducting pest risk analyses. Use of methods to initiate, conduct, and report this plant pest risk assessment is consistent with guidelines provided by these organizations. Our use of biological and phytosanitary terms such as Aintroduction@ and Aquarantine pest@ conform with the NAPPO Compendium of Phytosanitary Terms (NAPPO 1995), and the Definitions and Abbreviations in the introduction of International Standards for Phytosanitary Measures, Section 1 B Import Regulations: Guidelines for Pest Risk Analysis (FAO 1996).

Pest risk assessment is one component of an overall pest risk analysis. The Guidelines for Pest Risk Analysis provided by the FAO (1996) describes three stages in pest risk analysis. The stages are initiation - Stage One, risk assessment - Stage Two and risk management - Stage Three. This document satisfies the requirements of FAO Stage One and Two. We have not addressed Stage Three herein. In addition, The FAO defines pest risk assessment as "Determination of whether a pest is a quarantine pest and evaluation of its introduction potential" (FAO, 1996). Also, the FAO defines Quarantine Pest as "A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled" (FAO 1995, NAPPO 1995).

Purpose

The purpose of this document is to provide information on the pest risk posed by the importation of ADP into the United States. Additionally, port of entry interception and domestic detection of exotic longhorned beetles that have life stages difficult to detect are on the increase. This assessment is a response to concern about the pest risk these beetles present.

Scope

We have confined the scope of this document to three taxa of longhorned beetles (Coleoptera: Cerambycidae) intercepted from ADP. Other than Scolytidae, no interception or detection records of wood boring insects (e.g., Buprestidae and Siricidae) were found. Recent records account for interceptions of *Hypothenemus sp.* and Scolytidae spp. taken in association with Chinese ADP (PIN 2001). However, these bark beetle taxa are not considered herein because their biological habits, including external evidence of entry into the bark and gregarious nature, allow for ease of detection by visual inspection.

This report will also rate the specific factors of likelihood of entry, likelihood of establishment and the consequences of introduction to evaluate the quarantine action status of these wood boring insects. We also give an overall rating for the pest risk potential. Finally, the completed document will allow the reader fully to realize the potential for harm to agriculture and the environment if these insects were to gain a foothold in the United States.

II. Risk Assessment

1. Initiating Event: Proposed Action

In April 1999, nurserymen in Georgia found adults and larvae of the Citrus longhorned beetle (CLB), *Anoplophora chinensis* (Forester) twice in a greenhouse. The beetles were observed emerging from artificially dwarfed crape myrtle plants imported from the People's Republic of China. They also observed the beetles to move throughout the greenhouse. Two months later, a home owner in Wisconsin discovered a beetle after purchasing an ADP from an unknown origin. The Agricultural Research Service, Systematic Entomology Laboratory (SEL) identified the beetle as the White Spotted Longhorned Beetle (WSLB), *Anoplophora malasiaca* (Thomson). Since 1996, quarantine officials intercepted beetles in the genus *Anoplophora* several times from Asian ADP imported by Europe Union countries (Appendix A, Table 1). More recently, in Massachusetts, a state inspector detected *Anoplophora* sp. larvae feeding in Chinese ADP imported into the United States (PIN, 2001). In June 1999, PPQ Officers intercepted an unidentified longhorned beetle in Miami, Florida during an intensive inspection of ADP imported from the People's Republic of China. PPQ Officers intercepted another longhorned beetle, *Chlorophorus diadema* (Motschulsky), in August 1999, in an ADP seized in San Francisco, California. The shipper imported the plant from the People's Republic of China.

A review of the above incidents illustrates the need to evaluate the current United States regulations intended to prevent entry of pests associated with imported ADP. Repetitive interceptions in the United States (e.g., Georgia, Wisconsin, and Massachusetts), and Europe resulting from beyond the port of entry inspection provides proof that detecting wood borers associated with ADP is difficult. Both CLB and WSLB are considered dangerous orchard pests in their native countries. These insects can infest and kill many hardwood trees that include *Citrus* sp., cherry, apple and pear. The genus *Anoplophora* represents an extremely destructive group of wood borers and warrant concern.

2. Previous Risk Assessments

We reviewed the following pest risk assessments related to this work.

- USDA, APHIS 1997. Penjing Plants From China. Volume I.

- Anonymous. 1997. Anoplophora malasiaca and Anoplophora chinensis. In: Quarantine Pests For Europe (Ed. by Smith, I.M.; McNamara, D.G.; Scott, P.R.; Holderness, M.), pp. 57-60. 2nd ed. CAB International, Univ. Press, Cambridge.

3. Pest Interceptions

Port of Entry 309 Port Information Network records were reviewed for the period 1985 through 2001 (PIN 2001). The search yielded one interception, representing the family Cerambycidae, in association with ADP. Our review did not produce records enough to justify rigorous assessment of other of wood boring taxa.

We list all United States sources for detections and interceptions of longhorned beetles taken to date in Appendix A, Table 1. Also, recorded in Appendix A, Table 1, are interceptions of adult and immature *Anoplophora* species that entered Germany and The Netherlands while infesting ADP that originated from China and Japan (Anon., 1997).

4. Quarantine Pests

In this risk assessment, we did not consider the full range of quarantine pests likely to be associated with ADP. Instead, this assessment focuses on intercepted insect borers, in the beetle family Cerambycidae (longhorned beetles). Appendix A, Table 1 lists quarantine significant cerambycid beetles intercepted from these materials by PPQ, species that have infested properties by escaping detection at ports of entry and multiple European interceptions.

In addition, PPQ frequently intercepts longhorned beetle larvae from various types of cargo. However, Systematic Entomology Laboratory (SEL) insect taxonomists can rarely identify this immature life stage to the species level, because scientists have not described larvae of most longhorned beetle species in the literature. This limitation means that the identification goes only to the genus level (e.g., *Anoplophora* sp.), subfamily level (e.g., Lamiinae) or family level (e.g., Cerambycidae). Consequently, the "Lamiinae sp." interception (i.e., the subfamily containing CLB and WSLB) listed in Appendix A, Table 1, is not thoroughly assessed, and may represent a wood borer with a greater potential to cause more damage than that of the others.

The intercepted quarantine pests analyzed for this assessment are:

Anoplophora chinensis (Forester)
Anoplophora malasiaca (Thomson)
Chlorophorus diadema (Motschulsky)

5. Likelihood of Entry and Establishment, and Consequences of Establishment: Qualitative Assessment

This section considers the three quarantine pest taxa listed above, i.e., *Anoplophora chinensis* (Forester), *Anoplophora malasiaca* (Thomson), and *Chlorophorus diadema* (Motschulsky). We rate each organism group for likelihood of pest entry, likelihood of establishment, and consequences of introduction using high, medium, or low as descriptors, and provide an overall rating of pest risk potential.

Because we evaluated only these three pest taxa, we believe the cumulative risk posed by ADP is greater than that indicated by this assessment.

Anoplophora chinensis, Citrus Longhorned Beetle (CLB)

Factor Summary for *Anoplophora chinensis*

Factor	Rating
Likelihood of Entry	High
Likelihood of Establishment	High
Consequences of Introduction	High
Pest Risk Potential	High

Quarantine Status

Notwithstanding the detections of Citrus longhorned beetle (CLB) in Georgia, there are no breeding populations of this species in the United States (Duffy 1968, Poole & Gentili 1996). APHIS considers all *Anoplophora* sp. including CLB as quarantine pests.

Likelihood of Entry

CLB infests a wide variety of woody host plants, listed below under Likelihood of Establishment. Some of these hosts, such as fig and maple, are commonly imported into the United States as ADP. The 1999 Athens, Georgia detection of CLB in artificially dwarfed crape myrtle represents an apparent new host record for the beetle. This recent discovery suggests that CLB may infest other ADP not currently known as CLB hosts. The find in Georgia also illustrates the difficulty in detecting CLB in imported ADP, in that the crepe myrtle plants had passed PPQ port of entry inspection.

In other instances in Europe, records account for the observation of *Anoplophora* spp. (adults and larvae) entering Germany and the Netherlands in association with ADP (Anon. 1997). These interceptions, identified as "*Anoplophora*" spp., may represent unrecognized Citrus longhorned beetles.

We give a high rating for likelihood of entry several reasons. First, ADP provides a known pathway, in that quarantine officials have already intercepted CLB from ADP entering the United States and Europe. Second, CLB has cryptic life stages that are difficult to detect during inspection. And third, CLB infests different woody plants eligible for entry into the United States that are or may be imported as ADP.

Likelihood of Establishment

In China CLB is known to occur from the north in Liaoning Province, throughout the east, to the west in Sichuan, and south to the Yunnan Province (Anon. 1994). CLB also occurs in Hong Kong, Hainan Island, Taiwan, Korea, Macau, Myannmar, Vietnam, Japan and Ryukyu Islands. (Gressitt 1942; Duffy 1968; Waterhouse 1993; EPPO 1994).

The host list for CLB is extensive. Primary hosts are *Citrus aurantifolia, C. aurantium, C. limonia, C. grandis, C. maxima, C. nobilis,* and *C. sinensis* (Gressitt 1942, Lieu 1945). Other hosts include apple, apricot, cherry, chestnut and chinese chestnut, fig, litchi, longan, loquat, peach, pear and pineapple, pecan, pigeon pea, Acer, *Atlantica buxifolia, Broussonetia papyrifera, Casuarina equisetifolia, Hibiscus mutabilis, Melia azedarach, Morus alba, Morus* sp., *Platanus orientalis, Populus alba, Salix babylonica, Stransvaesia benthamiana, Stylurus robusta,* and *Cryptomeria japonica* (Gressitt 1942, Lieu 1945, Duffy 1968, Wang and Chen 1984, Anon. 1994; Anon. 1997). Apparently the Athens, Georgia interception in *Lagerstroemia indica* (crape myrtle) is a new host record for CLB.

A search for current literature on the biology of the Citrus longhorned beetle produced poor results. Therefore, the fundamental biology and behavior described herein are according Lieu (1945) unless otherwise cited. Field studies of the mating behavior and diurnal activity of *A. chinensis* is described in detail by Wang et al (1996) and Wang (1998).

In China, Citrus longhorned beetles have one generation per year. The adults emerge from April to August and are most prevalent in May to July, but larvae may be present throughout the year. Healthy more vigorous host trees attract this insect and the adults are active daytime flyers, especially on sunny days (Lieu 1945, Wang et.al 1996). Females lay eggs on the lower portion of the living tree trunk or on exposed roots. The lifetime number of eggs laid, depending on the size of the female, is approximately 8-20 per female. Females oviposit one egg in T-shaped slits cut into the bark by the female's mandibles. Eggs persist one to three months before the larvae hatch out and tunnel into the vegetative growing stages (root, stem, and trunk) of the tree. The larvae then pupate in chambers, normally at the end of their channel, in the heart wood in early spring. The pupa and pre-adult stage is present for about one and one-half months. Adult feeding causes damage to petioles and young bark of attacked hosts. The adults live for about one month. CLB immatures are as large as Asian longhorned beetle (*Anoplophora glabripennis*) larvae, measuring up to 56 mm long and 10 mm wide. Adult specimens of *A. chinensis* and *A. malasiaca* are taxonomically difficult to separate, and taxonomic work in the future on these closely related species may reveal them to be one species (Anon. 1997).

The Citrus longhorned beetle occurs in China from approximately 18°N to 45°N and 105°E – 127°E (Hammond 2000). This area coincides with similar climatic and vegetative areas in North America, especially the eastern and southeastern United States, that have conditions conducive to CLB establishment (USDA 1990, Hammond 2000).

CLB life stages feed on many East and Southeast Asia fruit and ornamental hosts in at least 16 plant families (Wang et al 1996). Like other wood borers, CLB can be transported as eggs, larvae, pupae and adults in association with ADP. Lieu (1945) observed adult beetles as active flyers, especially on sunny days. Furthermore, Lieu (1945) observed that newly emerged adults flew readily to citrus, where they feed on the petioles of leaves and bark of twigs. However, from all the literature reviewed no information was available to suggest on how far these beetles may fly. With one generation per year and the ability to produce few progeny (=20 per female), the CLB apparently has low reproductive potential.

We rate likelihood of establishment as high for the following reasons. First, a suitable climate and hosts in at least four plant hardiness zone areas of the United States concur with that of CLB's range in China and Southeast Asia. Second, *A. chinensis* has a very wide host range that coincides with many hosts that occur in the United States. Third, CLB could disperse by flight or move secretly while occupying a host, but has low reproductive potential. Although CLB has a low reproduction potential with an unknown flight range, this species can easily move in wood products by man. Establishment in the United States is feasible for this pest, but infestations would probably spread slowly and over a long period of time.

Consequences of Introduction

Researchers of CLB regard this insect as one of the most destructive wood boring pests of fruit trees (Gressitt 1942; Lieu 1945; Wang et al. 1996). CLB weakens and kills many trees annually, especially young trees and is a major citrus pest that causes substantial economic loss of citrus in the Orient (Gressitt 1942; Hanson 1963; Hill 1983; Wang et al. 1996). *Anoplophora chinensis* is a harmful pest of apple, pear, fig, cherry, peach, loquat, apricot, chestnut, Chinese chestnut, longan, pineapple and litchi in China to include Hainan and Taiwan (Anon. 1994). The Netherlands reported individual adults damaging outside trees and shrubs in summer (Anon. 1997). CLB also causes extreme damage to *Cryptomeria japonica* in the Jiangsu Province of China (Wang and Chen 1984).

Early control methods consisted of hand catching adults, crushing larvae or snagging larvae with wire, injecting chemicals into tunnels, burning branches, and whitewashing tree trucks to deter oviposition (Gressitt 1942; Hill 1983). More recent methods to control *A. chinensis* use hymenopteran predators and parasites. For example, application of *Oecophylla smaragdina* ants gave good control of CLB in southern Fujian, China and reduced or eliminated the need for chemicals (Yang 1984). The bracond wasp, *Ontsira* sp., successfully attacks CLB larvae (Zhang 1986). Also, the use of pathogenic nematodes (*Steinernema feltiae* [*Neoaplectana carpocapsae*]) and fungi *(Beauveria*) prove useful to control *Anoplophora* spp. larvae (Kashio 1986; Fan 1986; Anon. 1997). Experiments for chemical control of CLB tunnelling in *Casuarina equisetifolia* in Zhejiang Province forests proved 91-100% effective with the use of Omethoate and monocrotophos (EPPO 1996).

We rate the Citrus longhorned beetle high for consequences of introduction. This insect is a major pest of citrus and other fruit trees, often killing them. CLB also weakens trees making them more susceptible to disease and wind damage (Anon. 1997). Controlling this pest would increase the cost of production in commercial applications. Trees killed or weakened by CLB would reduce crop yields and profit. Establishing a quarantine that restricts movement of products would have a negative impact on domestic and international markets. Also, we may require toxic chemicals or the introduction of exotic biological control agents to control this pest. A widespread infestation could cause loss of aesthetic value to properties. For example, the presence of citrus canker in South Florida has stimulated the removal of thousands of trees in residential neighborhoods. This removal of citrus trees in residential areas has caused many homeowners to complain and even sue the State. We rate the total pest risk potential for CLB as high.

Anoplophora malasiaca, White-Spotted Longhorned Beetle (WSLB)

Factor Summary for *Anoplophora malasiaca*

Factor	Rating
Likelihood of Entry	High
Likelihood of Establishment	High
Consequences of Introduction	High
Pest Risk Potential	High

Quarantine Status

Currently, there are no populations of this species that feed on and damage living trees in the United States (Duffy 1968, Poole & Gentili 1996). APHIS considers all *Anoplophora* spp. including WSLB as quarantine pests.

Likelihood of Entry

In 1999, a homeowner in Wisconsin detected a beetle at large near artificially dwarfed trident maples. Dr. Stephen Lingafelter of ARS, SEL identified the beetle as the White-Spotted longhorned beetle (Lingafelter 1999; Appendix A, Table 1). These plants, imported from the Orient, passed PPQ port of entry inspection. Inspectors then released the plants into commerce. In other instances in Europe, records account for the observation of *Anoplophora* spp. (adults and larvae) entering Germany and the Netherlands in association with ADP (Anon. 1997). Again, it is important to note here that above interception identified as "*Anoplophora*" spp. may represent unrecognized White-Spotted longhorned beetles. This species has life stages that are difficult to detect during port of entry inspection. Moreover, WSLB may infest numerous types of ADP that are eligible for entry into the United States. Considering the above evidence, we justify a high rating for the entry potential of WSLB.

Likelihood of Establishment

Anoplophora malasiaca occurs in Korea, southeastern China, Taiwan, and is widespread throughout the Japan islands (Lingafelter 1999; Anon. 1997). WSLB is not known to occur in the northern island of Hokkaido in Japan (Anon. 1997). Chang (1975) stated that *A. malasiaca's* hosts include at least 68 species of trees that constitute 19 families. According to Lingafelter (1999), citrus is the most important host and this species is abundant in orchards in Japan and South Korea. In the Sichuan Province of China hosts include apple, pear, cherry and litchi (Anon. 1994). Other hosts include *Platanus*, *Acer, Alnus, Robinia*, *Zelkova*, and *Salix* (Anon. 1997; Lingafelter 1999). Common hosts shared by *A. malasiaca* and *A. chinensis* include *Ficus, Hibiscus, Mallotus, Pyrus, Rosa* (Anon. 1997) and Acer.

The biology of *A. malasiaca* appears to parallel that of *A. chinensis*. In his memorandum on WSLB, Lingafelter (1999) summarizes its biology as follows. Larvae develop usually around the root crown or base of trees, adults emerge during summer, live for about 2-3 weeks, mate, and lay eggs on the host trees and the cycle continues. Some adult feeding will take place on the petioles of leaves, but most damage is done over the year internally by larvae. WSLB morphology, larval feeding, egg laying and oviposition habits vary depending on the host attacked (Chang 1975). An early researcher who studied *A. malasiaca's* egg laying habits in citrus reported the average number laid by a female in her lifetime to be 30 -70 (Adachi 1988). Adachi (1988), to clarify the fertility of WSLB, reported the number of eggs laid to be 193.8 ∀65.2 per female during a life span of 77.6 ∀20.3 days. Temperature and female body size also influenced the number eggs laid per female. Adachi's (1994) laboratory study on the development and life cycle of WSLB reports a 1-2 year life cycle.

A. malasiaca. has a wide distribution within temperate, tropical and subtropical regions similar to those plant hardiness zones in North America. This insect has multiple hosts that include many forest, fruit, and ornamental tree species that also occur in the United States. Furthermore, WSLB can easily be dispersed through movement of host material by man. In addition, adults can fly to other hosts to establish new populations, and have a high reproduction potential. Thus, we rate likelihood of entry as high.

Consequences of Introduction

This species is very important in Japan and Korea and is an important factor in yield loss of citrus in these countries (Lingafelter 1999; Mitomi 1990; Adachi 1988; Anon, 1981). The WSLB is a harmful pest of apple, pear cherry and litchi in China (Anon. 1994). This species is the most detrimental borer to alder plantations in Japan (Anon. 1972). Feeding by WSLB larvae weakens and kills trees, especially young trees, and makes trees more liable to disease and wind damage (Anon. 1997). The Netherlands reported individual adults damaging outside trees and shrubs in summer (Anon. 1997).

In Japan, growers use chemical treatment to control this species in citrus orchards (Anon. 1997). Chemical studies on the control of WSLB prove effective on experimental plots of alder stands in Japan (Inouye 1970). The use of pathogenic nematodes (*Steinernema feltiae* [*Neoaplectana* *carpocapsae*]) and fungi *(Beauveria*) are also applied to control *Anoplophora* spp. larvae (Kashio 1986; Fan 1986; Anon. 1997). Physical barriers such as the use of fine wire mesh can successfully prevent female oviposition on tree trunks (Anon. 1997).

We rate the White-Spotted longhorned beetle high for consequences of introduction. The summary in this section is similar to that for CLB. Both insects are major pests of citrus and other fruit trees, often killing them. WSLB and CLB also weaken trees making them more susceptible to disease and wind damage (Anon. 1997). Controlling these pests would increase the cost of production, reduce yields and increase the market price of fruit. Establishing quarantines that restrict movement of a commodity would have a negative impact on domestic and international markets. Also, we would require toxic chemicals to control these pests, or the introduction of exotic biological control agents may be required. A widespread infestation could cause loss of aesthetic value to properties. For example, the presence of citrus canker in South Florida has stimulated the removal of thousands of trees in residential neighborhoods.

We rate the total pest risk potential for WSLB as high.

Chlorophorus diadema

Factor Summary for *Chlorophorus diadema*

Factor	Rating
Likelihood of Entry	Medium
Likelihood of Establishment	High
Consequences of Introduction	High
Pest Risk Potential	High

Quarantine Status

Chlorophorus diadema is listed by Plant Protecton and Quarantine (PPQ) as an actionable pest and is not known to occur in the United States (309 PIN database 2001; Duffy 1968, Poole & Gentili 1996). APHIS considers organisms recognized as *Chlorophorus* sp. as quarantine pests.

Likelihood of Entry

In 1999, PPQ Officers in San Francisco, California inspected and released a large shipment of Chinese ADP. However, PPQ seized one plant because it lacked proper papers as to its identity. The plant was found pest free at the time of inspection, identified as *Styrax* sp., safeguarded, and scheduled for destruction. While waiting for destruction, a beetle determined as *Chlorophorus diadema* emerged from the plant before the mitigating act could take place. This incident clearly exemplifies the difficulty of detecting internal feeders in imported ADP. We rate the likelihood of entry for this species as medium because there are no reoccurring port of entry interceptions of this beetle. No detections of *C. diadema* occurred beyond port of entry inspection locations, to date. In addition, despite the medium rating here, one should realize that the inspector intercepted this pest in association with a tree not recognized as a host to this beetle. Consequently this pest's host range is wider than known and may include taxa that distributors sell as ADP other than known hosts - *Vitis*, *Robinia*, birch and *Populus*.

Likelihood of Establishment

Chlorophorus diadema occurs in Russia (on the China border near the Ussuri River), throughout

China, Taiwan, Korea, and Japan (Cherepanov 1988; Wu 1977). This species' hosts include *Vitis*, birch, oak, *Robinia pseudoacacia, Maakia amurensis* and *Populus* spp. (Cherepanov 1988; Li & Wu 1993).

The following review of the biology of *C. diadema* is according to Cherepanov (1988). This species is ecologically associated with broadleaved forests. Larvae develop in the trunk of its hosts. Adult beetles emerge in the summer and are more abundant in the latter part of July. Adults visit flowers and fly to preferred host trees. The female inserts eggs singly in cracks in the bark. The egg-laying capacity of this species is unclear, but the author observed a pre-ovipositing female with 38 eggs in her abdomen. Approximately 12-13 days after female oviposition the eggs hatch. Eggs hatch July through August. A newly hatched larva moves under bark and begins to make longitudinal tunnels. Larvae continue to tunnel upward longitudinally, filling their tunnels with frass while moving deeper into the wood. Larvae make pupa cells at the end of the galleries. Pupation begins mid-May and finishes in June and lasts two to three weeks. Adults emerge, the cycle begins again, and the generation is completed in two years.

Chlorophorus diadema missed detection in an imported ADP during a PPQ port of entry inspection. This species's presence in tropical and subtropical regions, and wide host range coincides with climatic zones and hosts existing in the United States. Man can move this insect in plants and commence, and this species is motile in its biology. Furthermore, in comparison to the other taxa assessed herein, this species may have a moderate reproduction potential. We give a high rating for likelihood of establishment potential *Chlorophorus diadema*.

Consequences of Introduction

According to Shen & Li (1983), *C. diadema* is a pest of *Robinia pseudoacacia* in the Province of Jiangsu, China. They reported the beetle as damaging 5-10cm diameter locust logs. They have controlled this pest by various chemicals and by cutting trees. This species is also a pest of grapevines in Taiwan were larvae damage the vines by excavating galleries in the xylem (Wu 1977). Duffy (1957, 1968) and Cherepanov (1988) cite several *Chlorophorus* spp. as pests. For example, Duffy (1957) describes *Chlorophorus varius* as "a recognized secondary pest of various orchard trees, and a pest of grapes, sesbania hedges, and able to kill trees. El-Minshawy (1976) considers this species a pest of grapes in Egypt and reports that black oil treatment applied to pruned branches give good protection against beetle attacks.

We rate the consequences of introduction of *Chlorophorus diadema* as high. This species can kill living trees. We may require the use of chemicals and the introduction of nonidigenous biological agents to control this pest. Introduction of this beetle could also increase the cost of production of grape and give lower yields if established on this host. We rate the total pest risk potential for *Chlorophorus* *diadema* as high.

III. Literature Reviewed

Adachi, I. 1988.
Reproductive Biology of the White-Spotted Longicorn Beetle, *Anoplophora malasiaca* Thomson (Coleoptera: Cerambycidae), in Citrus Trees. Applied Entomology and Zoology. 23: 256-264.

Adachi I, and R. Korenaga, 1989 (abstract).
Control methods for *Anoplophora malasiaca* (Thomson)(Coleoptera: Cerambycidae) in Citrus Groves. I. Comparison of effects in several methods for preventing oviposition. Applied Entomology and Zoology. 24(3): 315-317.

Adachi, I. 1994.
Development and Life Cycle of *Anoplophora malasiaca* (Thomson) (Coleoptera: Cerambycidae) on Citrus Trees under Fluctuating and Constant Temperature Regimes. Applied Entomology Zoology. 29 (4): 485-497.

Anonymous. 1972.
Insect pests in the stands of the Alder tree, *Alnus inokumai* Murai et Kusaka. Bulletin of the Government Forest Experiment Station, Meguro. 248: 69-87.

Anonymous. 1981.
Major Citrus Insect Pests in Japan, Japan Plant Protection Association Handbook. 16p.

Anonymous. 1994.
Harmful pests of China fruit trees (second edition). China Agriculture Science Institute. China Agriculture Press. (Translation by USDA, APHIS). 1063p.

Anonymous. 1997.
Anoplophora malasiaca and *Anoplophora chinensis*. In: *Quarantine Pests For Europe (Ed. by Smith, I.M.; McNamara, D.G.; Scott, P.R.; Holderness, M.), pp. 57-60. 2nd ed*. CAB International, Univ. Press, Cambridge.

Anonymous. 2000a.
Climate. In: *Hammond World Atlas*, pp. 30-31. 3rd ed. Hammond World Atlas Corporation, Italy.

Anonymous. 2000b.
Vegetation. In: *Hammond World Atlas*, pp. 32. 3rd ed. Hammond World Atlas Corporation, Italy.

Chang, S.C. 1975 (abstract).
The Host Plants, Egg Laying and Larval Feeding Habits of Macularia White Spotted Longicorn Beetles. Journal of Agriculture and Forestry. 24: 13-20.

CFR (Code of Federal Regulations) 319.37. 2000.
Foreign Quarantine Notices. Subpart-Nursery Stock, Plants, Roots, Bulbs, Seeds and Other Plant Products.

Cherepanov, A.I. 1988.
Cerambycidae of Northern Asia. Volume 2, Part II: Cerambycinae. Oxonian Press Pvt. Ltd., New Delhi, India. 292p.

Duffy, E.A.J. 1953.
A Monograph of the Immature Stages of British and Imported Timber Beetles (Cerambycidae). Trustees of the British Museum (Natural History). London, United Kingdom. 350p.

Duffy, E.A.J. 1957.
A Monograph of the Immature Stages of African Timber Beetles (Cerambycidae). Trustees of the British Museum (Natural History). London, United Kingdom. 338p.

Duffy, E.A.J. 1963.
A Monograph of the Immature Stages of Australasian Timber Beetles (Cerambycidae). Trustees of the British Museum (Natural History). London, United Kingdom. 235p.

Duffy, E.A.J. 1968.
A Monograph of the Immature Stages of Oriental Timber Beetles (Cerambycidae). Trustees of the British Museum (Natural History). London, United Kingdom. 434p.

El-Minshawy, A.M. 1976 (abstract).
On the control of the cerambicid beetle *Chlorophorus varius* Mull. (Coleoptera, Cerambycidae) in grape orchards, with some biological observations. Agricultural Research Review. 54 (1): 167-169.

EPPO, 1994.

Reporting Service. CIDSS/VN. 1994-08.

EPPO, 1996.
Reporting Service. Control of *Anoplophora chinensis* in China. 1996-08.

EPPO, 1997.
Reporting Service. Macau. 1997-09.

EPPO, 1998.
Reporting Service. Bonsai. 1998-08

EPPO, 2001.
Reporting Service. Phytosanitary incidents reported on bonsais and pot plants in the Netherlands. 2001-045.

FAO. 1996.
International Standards for Phytosanitary Measures. Part 1 - Import Regulations: Guidelines for Pest Risk Analysis (Draft Standard). Secretariate of the International Plant Protection Convention, Food and Agriculture Organization of the United Nations. Rome, Italy.

Fan, M.Z., C. Guo, and B. Zhang. 1986 (abstract).
Comparison of the infectivity of *Beauveria bassiana* to four species of truck-boring insects. Chinese Journal of Biological Control. 2: 3, 126-128.

Gressitt, J.L. 1942.
Destructive Long-Horned Beetle Borers at Canton, China. Lingnan Natural History Survey and Museum, Special Publication No. 1. Canton, China: Lingnan University. 60p.

Hanson, H.C. 1963.
Diseases and Pests of Economic Plants of Central and South China, Hong Kong and Taiwan (Formosa). A Study Based on Field Survey Data and on Pertinent Records, Material, and Reports. American Institute of Crop Ecology, Washington, D. C.

Hill, D.S. 1983.
Agricultural Insect Pests of the Tropics and Their Control (2nd edition). Cambridge University Press, Cambridge, UK. 444p.

Inouye, M., S. Kodama, and M. Inoue. 1970 (abstract).

Effects of the insect control at experimental field in the growth of *Alnus* species. Technical Note, Oji Institute for Forest Tree Improvement. No. 90. 5p.

Kashio, T 1986 (abstract).
Application of bark compost containing entomogenous nematodes, Steinernema feltiae DD-136, for the control of white spotted longicorn beetle, Anoplophora malasiaca. Proceedings of the Association for Plant Protection of Kyushu, 32:175-178.

Lieu, K.O.V. 1945.
The Study of Wood Borers in China. I. Biology and Control of the Citrus-Root-Cerambycids, *Melanauster chinensis* Forster (Coleoptera). The Florida Entomologist, 27: 61-101.

Li, W. and C. Wu. 1993.
Integrated Management of Longhorn Beetles Damaging Poplar Trees. Beijing, China Forest Press, 290p.

Lingafelter, S.W. 1999.
U.S. Department of Agriculture, Systematic Entomology Laboratory, Agriculture Research Service. Memorandum to Robert Carlson, Entomologist, Subject: *Anoplophora malasiaca* (Thomson) (Coleoptera: Cerambycidae) newly recorded for the United States July 27, 1999. 2p.

Mitomi, M., E. Kuroda, and H. Okamoto. 1990 (abstract).
Ecological study of the White-Spotted Longicorn Beetle, *Anoplophora malasiaca* Thomson (Coleoptera: Cerambycidae). I. Investigation of Adult Emergence Holes in Citrus Orchards in Kagawa Prefecture. Japanese Journal of Applied Entomology and Zoology 34: 7-13.

PIN 309 Database. 2001.
Plant pest interception reports from U.S. ports of entry.

Poole, R.W. and P. Gentili (eds.) 1996.
Nomina Insecta Nearctica, a check list of the insects of North America. Volume 1, Coleoptera, Strepsiptera. Entomology Information Services, Rockville, Maryland. 827p.

Shen, Y. C., and Z.S. Li. 1983 (abstract).
Studies on *Chlorophorus diadema* Motsch. and *Lyctus linearis* Goeze. Journal of Najing Technological College of Forest Products. 1: 135-140.

Tsutsumi, T., T. Kashio, S. Hashimoto, Y.K.I. Gyoutoku, M. Narahara, 1990 (abstract).
Studies on biological control of white spotted longicorn beetles, *Anoplophora malasiaca*, by an entomogenous fungus, *Beauveria brongniartii*. IV. Field evaluation of hanging polyurethane foam sheet containing *B. brongniartii* conidia on citrus trees for the control of adult beetles. Proceedings of the Association for Plant Protection of Kyushu, 36:173-176.

U.S. Department of Agriculture (USDA). 1990.
USDA Plant Hardiness Zone Map. USDA-Agricultural Research Service (ARS). Miscellaneous Publication Number 1475. USDA-ARS, Washington, DC 20002.

Warmling, P., and H. Ahnlund. 1994 (abstract).
The longhorn beetle *Chlorophorus varius* introduced to Sweden. Entomologisk Tidskrift. 115 (1-2): 63-64.

Wang, T.Z. and D.P. Chen. 1984 (abstract).
Notes on the damage done by *Anoplophora chinensis* to *Cryptomeria japonica*. Res. Inst. For. Sci., Jiangsu, China. 6: 26-27.

Wang, Q., L.Y. Chen, W.Y. Zeng, and J.S. Li. 1996.
Reproductive behaviour of *Anoplophora chinensis* (Forster) (Coleoptera: Cerambycidae: Lamiinae), a serious pest of citrus. The Entomologist, 115 (1): 40-49.

Wu, L.L. 1977 (abstract).
A survey of the injurious insects of grape-vine in Taiwan. Plant Protection Bulletin, Taiwan. 19 (2): 78-100.

Wang, Q. 1998.
Evidence For A Contact Female Sex Pheromone In *Anoplophora chinenis* (Forester) (Coleoptera: Cerambycidae: Lamiinae). The Coleopterists Bulletin. 52 (4): 363-368.

Waterhouse, D.F. 1993.
The Major Arthropod Pests and Weeds of Agriculture in Southeast Asia. Australian Centre for International Agricultureal Reasearch (ACIAR), Canberra, Australia. Monograph No. 21: 141p.

Yang, P. 1984 (abstract).
The application of *Oecophylla smaragdina* Fabr. in South Fujian. Fujian Agricultural Science and Technology. 5: 23-25.

Zhang, L.Q., S.H. Song, J.X. Fan, X.Z. Li, Y.C. Liao, Y.L. Chen, and Z.Q. Li. 1986 (abstract). Reproduction and application of *Ontsina* sp. Natural Enemies of Insects. 8: (4): 232-237.

IV. Preparation, Consultation and Review

This pest risk assessment is prepared by Paul A. Courneya, Agriculturalist with the National Identification Services staff within PPQ (Plant Protection and Quarantine, Animal and Plant Health Inspection Service, U.S. Department of Agriculture).

This pest risk assessment is prepared using text and /or data contributed by:
Joseph Cavey, Branch Chief, National Identification Services.

The following individual reviewed a draft of this document:
Joseph Cavey, Branch Chief, National Identification Services.

The following subject matter experts were consulted for this assessment:
Joseph Cavey, Branch Chief, National Identification Services.
Steven Lingafelter, Research Entomologist, Systematic Entomology Laboratory, ARS
Donald M. Anderson, Research Entomologist, Systematic Entomology Laboratory, ARS (Retired)

APPENDIX A: Table of Insect Pests Intercepted in Association With Artificially Dwarfed Plants

Table 1. Artificially Dwarfed Plant Pest Detections and Interceptions (1985 - 2001)

Organism	Host	Origin and Pathway (Intercepted at U.S. ports of entry unless otherwise indicated)	Year Intercepted or Detected
Anoplophora spp.	*Acer buergeranum, Acer palmatum, Celastrus,* sp., *Cydonia sinensis, Malus micromalus, Sageretia* sp. Acer sp.	Imported into Germany and the Netherlands via China and Japan (Anon. 1997) China	1986,1988 2001
Anoplophora malasiaca (Thomson)	*Acer buergerianum*	Imported into the United Kingdom via Korea (EPPO 1998)	1998
Anoplophora chinensis (Forester)	*Lagerstroemia indica, Acer palmatum* *Acer palmatum*	China Imported into the Netherlands (EPPO 2000)	1999 2000
Anoplophora malasiaca (Thomson)	*Acer buergerianum*	Unknown (possibly China or Korea)	1999
Lamiinae sp.	*Zelkova serrata* *Wisteria* sp.	China China	1990 1999
Chlorophorus diadema (Motschulsky)	*Styrax* sp.	China	1999